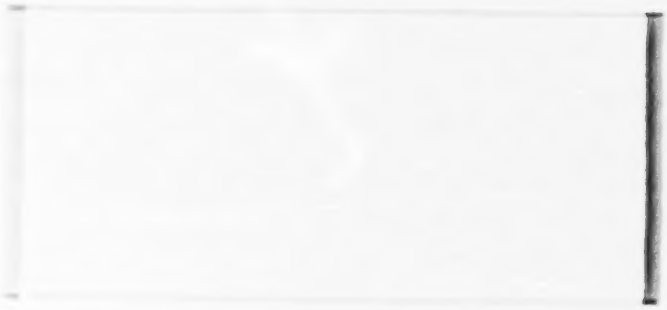

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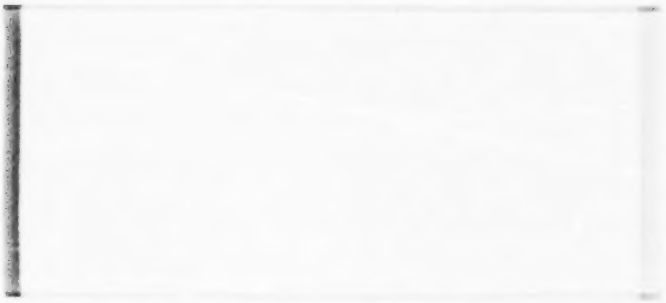

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EVALUATION OF RAIL LUBRICATORS AND GREASES

Prepared for

TRANSPORT CANADA
TRANSPORTATION DEVELOPMENT CENTRE

DEC 20 1987

C.J. Dalton Manager Track Research (CN Engineering), (retired)
C. Valade Sr. Engineering Assistant (CN Research)

Canadian National Railways
Technical Research Centre
3950 Hickmore Ave.
St. Laurent, Quebec
H4T 1K2

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The contents of this report reflect the views of the contractor and not necessarily the official views or policies of the Transportation Development Centre (TDC) of Transport Canada.

Un sommaire en français de ce rapport est inclus avant la table des Matières.

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C.J. Dalton, Manager Track Research (Engineering)(retired)
C. Valade, Sr. Engineering Assistant (Research)

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17. Abstract

In order to improve rail lubrication on Canadian National Railways, a research program with three objectives was initiated:

- To improve the mechanical performance of lubricators.
  - Rail Lubricator companies were made aware of CN's requirements. Most Companies complied and modified versions are now being field tested.
- To determine requirements for an all-year grease.
  - An all-year grease test procedure was developed and applied to greases submitted by suppliers. From these tests four (4) candidates for an all-year grease were found.
- To define the requirements for lubricator optimum location on track.
  - A lubricator installation procedure was drawn up which has since been used for recent lubricator installations.

With lubricator and grease suppliers now made more fully aware of lubrication performance standards, it is felt that all North American railroads will ultimately benefit.

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17. Résumé

Afin d'améliorer la lubrification du rail, le Canadien National a mis sur pied un programme de recherche visant les trois objectifs suivants;

- Améliorer le rendement mécanique des graisseurs.
  - Les manufacturiers de graisseurs ont été informés des exigences du CN et s'y sont conformés pour la plupart. Des appareils modifiés sont présentement à l'essai sur la voie.
- Etablir les exigences que devrait rencontrer une graisse toutes saisons destinée à remplacer les graisses présentement utilisées qui sont spécialement adaptées à l'été ou à l'hiver.
  - Une méthode d'essai a été mise au point et appliquée aux échantillons de graisses proposés par les fabriquants. Ces essais ont permis d'identifier quatre (4) candidats de graisses toutes saisons.
- Définir les règles à suivre pour choisir l'emplacement optimum des graisseurs le long de la voie.
  - Des procédures de positionnement ont été rédigées puis mises en application lors de récentes installations de graisseurs.

Grâce à ce projet les fournisseurs de graisses et de graisseurs sont maintenant conscients des exigences à satisfaire et sont en mesure de les remplir pour le plus grand bienfait des chemins de fer Nord Américains.

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Special thanks are due to the various rail lubricator and grease supply companies who contributed in various degrees to this work program. The railroads depend upon the railroad supply industry to continuously provide improved products to meet the ever more stringent demands of modern railroading. It is the general policy of Canadian National Railways to develop specifications for various products, and to award purchase orders in a competitive market to those who meet the required standards. The work of the various suppliers in helping to define and formulate those standards is appreciated.

EXECUTIVE SUMMARY

Rail related costs for Canadian National Railways amounted to something in the order of 130 million dollars in 1984. Tests at the Facility for Accelerated Service Testing (FAST) in Colorado, and tests on several U.S. railroads, have recently demonstrated that rail lubrication can significantly reduce train fuel energy consumption and rail wear. In order to obtain these potential savings from reduced rail wear and reduced fuel consumption, it is essential that rail lubricators and greases meet year-round, high performance standards. Work described in this report is a contribution toward achieving that goal. Specifically, research was conducted in three areas:

- Optimization of the physical performance of existing trackside lubricators.
    - Four (4) brands of lubricators were laboratory and field tested for reliability and effectiveness. Weight of grease pumped was monitored in temperatures ranging from +80°F (+26°C) down to -40°F (-40°C). Recommendations were made to lubricator manufactures. Abex, Moore and Steele provided some changes early on in the program. Tamper also responded but with some delay. The nitrogen gas operated SRS Clicomatic was discarded after unsuccessful test experiences.
- Development of laboratory physical evaluation tests for greases, with the objective of ultimately writing rail curve grease specifications.
    - All year grease candidates were tested at 80°F (26°C) down to -40°F (-40°C) for pumpability. The grease was also heated up to 140°F (60°C) in the wiper blades using infrared lamps and consistency was observed. Beads of the same grease were also placed on an aluminum plate sloped at 75° and placed in an oven and heated up to 180°F (82°C) and texture was compared to winter and summer greases currently used by CN.
- Provision of a specification for optimizing location of lubricators on track.
    - Guidelines were drawn up and used on several subdivisions on the system (Lac St. Jean, La Tuque, B.C. North Line) and proved to be effective. They locate lubricators where they would be more efficient and would not interfere with movement of traffic on grades. A formula was drawn up for 1-way and 2-way traffic incorporating certain restrictions (speed, sidings, grades, etc.).

While considerable headway has been made in all three areas of investigation, it is clear that continuing research will lead to further improvements. Technological development should never cease.

RÉSUMÉ EXÉCUTIF

Les frais reliés au rail encourus par le Canadien National en 1984 étaient de l'ordre de 130 millions. Des essais sur la voie du "Facilities for Accelerated Service Testing" (FAST), au Colorado, et sur certains chemins de fer Américains ont démontré que la lubrification du rail reduisait la consommation de carburant tout en prolongeant la vie du rail. Afin de realiser ces économies il est essentiel que les graisseurs et la graisse rencontrent à l'année longue les exigences de rendement qui en sont attendues. Les travaux décrits dans ce rapport visent ces deux objectifs. Plus précisément nous nous sommes penché sur trois domaines d'étude:

- Améliorer la performance des graisseurs.

    - Quatre (4) graisseurs de marques différentes furent essayés en laboratoire et sur le terrain afin d'établir leur fiabilité et leur efficacité. Le débit de graisse était noté a des températures variant entre +80°F (+26°F) et -40°F (-40°C). Des recommendations furent émises aux fabriquants de graisseurs. Abex et Moore & Steele modifièrent leurs appareils ; conséquence, Tamper les imita qu'un peu plus tard. Quant à l'appareil SRS Clico-matic, à l'azote comprimé, il fut éliminé de l'étude après quelques essais.

- Mettre au point des méthodes d'essai de graisse en laboratoire qui pourraient servir de point de départ à une norme portant sur les graisses toutes saisons utilisées sur la voie.

    - Des échantillons de graisses toutes saisons furent essayés à des températures variant entre +80°F (+26°C), et -40°F (-40°C), afin d'en déterminer la pompabilité. Les barres distributrices des graisseurs furent ensuite chauffées à l'aide de lampes infra-rouge afin d'observer la consistence des graisses à 140°F (60°C). Des filons des différentes graisses à l'essai, et des graisses d'été et d'hiver présentement utilisés par le CN furent placés côte-à-côte sur un plateau d'aluminum incliné à 75° que l'on mit au four à 180°F (82°C) afin d'en comparer la texture à chaud.

- Définir les règles à suivre pour choisir l'emplacement optimum des graisseurs le long de la voie.

    - Des normes d'installation furent rédigées et mises en application sur certaines subdivisions (Lac St-Jean, La Tuque, B.C. Nord). Ces normes visent à placer les graisseurs là où ils seront les plus efficaces. Elles s'appliquent au traffic à deux sens comme au traffic à sens unique tout en tenant compte de certaines restrictions (vitesse, voie d'évitement, pente, etc.).

Un progrès considérable a été réalisé dans ces trois domaines mais il est évident que d'autres améliorations sont encore possibles et que pour cette raison les recherches dans ce domaine devraient se poursuivre.

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1. INTRODUCTION

The Report entitled "Rail Lubrication Study" published in July 1981 (internal CN) dealt primarily with the mechanical performance of the four lubricators studied: RACOR, MOORE & STEELE, TAMPER and S.R.S.

In the recommendations it was evident that this work must be progressed. Therefore this report will address several related facets of rail lubrication, namely:

- optimizing performance of existing lubricators
- developing physical evaluation tests for grease
- providing a specification system for the location of lubricators on track

Two of the lubricators studied in the July 1981 report were more amenable to improvement, i.e. the M & S and the Racor lubricators. The Tamper and the SRS units required a great deal more work. Thus this report will emphasize improvements to the Racor and M & S lubricators.

2. PURPOSE

- To field evaluate modified versions of Racor, Moore & Steele, and Tamper lubricators for grease delivery and reliability in order to write guidelines for further lubricator purchases.

- To laboratory and field evaluate candidates for an all-year grease in order to write a specification for future purchase of all-year greases which would replace summer and winter grades presently used.

- To provide guidelines for future lubricator installations on track in order to improve the effectiveness of lubricators, and to have better distribution of grease along the track.

3. IMPROVEMENTS TO EXISTING LUBRICATORS

3.1 M & S LUBRICATOR MODEL 561

At the time of publishing the 1981 report a copy of the portion relating to the M & S lubricator was forwarded to the company. From subsequent correspondance and meetings it was agreed that a cooperative undertaking involving CN Rail Research and M & S would be instituted to provide an optimum product. The following items were addressed and the improvements are documented below:

- The plunger assembly which is activated by passing wheels was not acceptable for high speed track as the upper spring failed after only a few weeks. This is described in detail in the July 1981 report.

  After several false starts by both CN and M & S, the solution to the continued failure of the upper spring was found to be a steel and hard rubber insert to replace the spring. The latest version was in service for approximately 1 year before failure.

- The design of the wiper blocks on the original M & S lubricator dictated that the lubricator be installed on tangent track because the wiper blocks were exposed to excessive flange wear when installed on spirals. Additionally, the wiper block outlet was too low for wheel flange pick-up of the grease. Also, because the wiper block was too short, it was not possible to pump sufficient grease to adequately lubricate passing wheel flanges.

As a result, a new wiper block was designed which incorporated the following features as shown in Figure 2.

  - wiper blocks now produce a 6" head of grease compared to 1/2" on the original model.

  - wiper block outlets are now set a 7/8" below head of rail compared to 1-1/16" before.

  - the rail at the location of each wiper block is ground to 20° to allow the wiper block to be recessed under the head of the rail. Therefore these wipers should be installed in spirals to ensure better lubrication of the gauge face of the high rail.

- Because of the redesign of the wiper blocks it was necessary to increase the grease output of the pump. As a result, the grease pump was changed from a 3/8" outlet to a 1/2" outlet.

M & S PLUNGER BLOCK SPRING REPLACEMENT

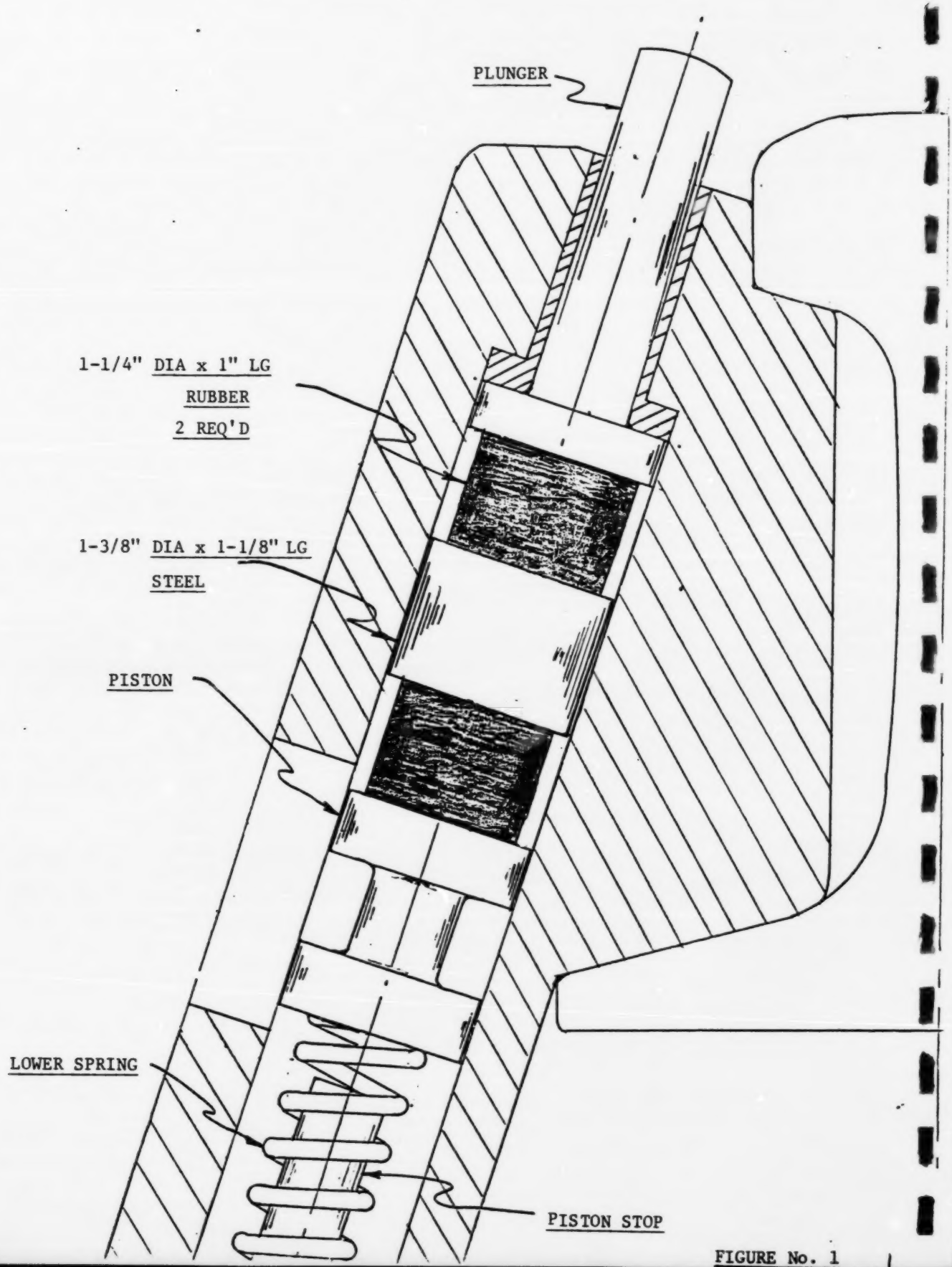


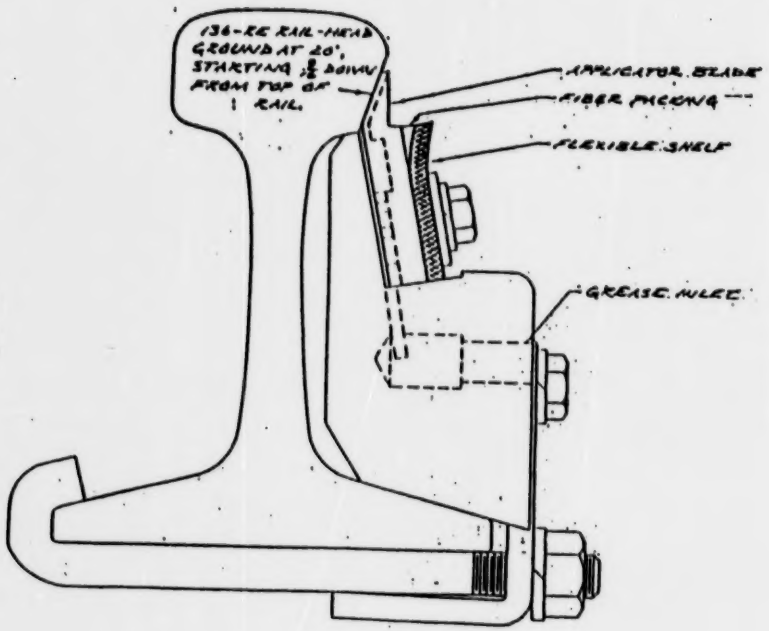
FIGURE No. 1

- From the 1981 report it was evident that, to eliminate the necessity to puddle the grease, a slope had to be incorporated in the bottom of the tank. This is now standard for all M & S lubricators purchased by CN (Figure No. 3).

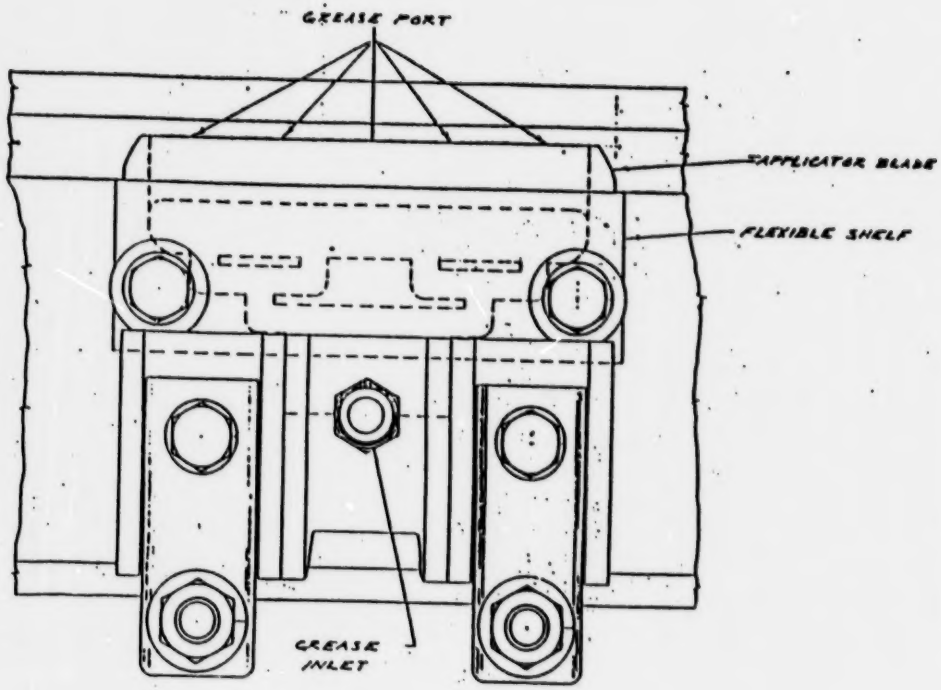
  One M & S lubricator, incorporating all the changes listed above, was installed at Mi. 13.4 on the Alexandria Subdivision on November 10, 1983. Inspections on January 25, 1984 and March 15, 1984 showed the unit to work satisfactorily even during the severe winter conditions.

  Two were put in service on the Great Lakes region in 1984 and observations show them to work satisfactorily.

  Moore & Steele is presently developing an electric version and a hydraulic version which will be field tested in the near future.


136-RE RAIL-HEAD GROUND AT 20°, STARTING 1/2 BELOW FROM TOP OF RAIL.
APPLICATOR BLADE
FIBER PACKING
FLEXIBLE SHELF
GREASE INLET

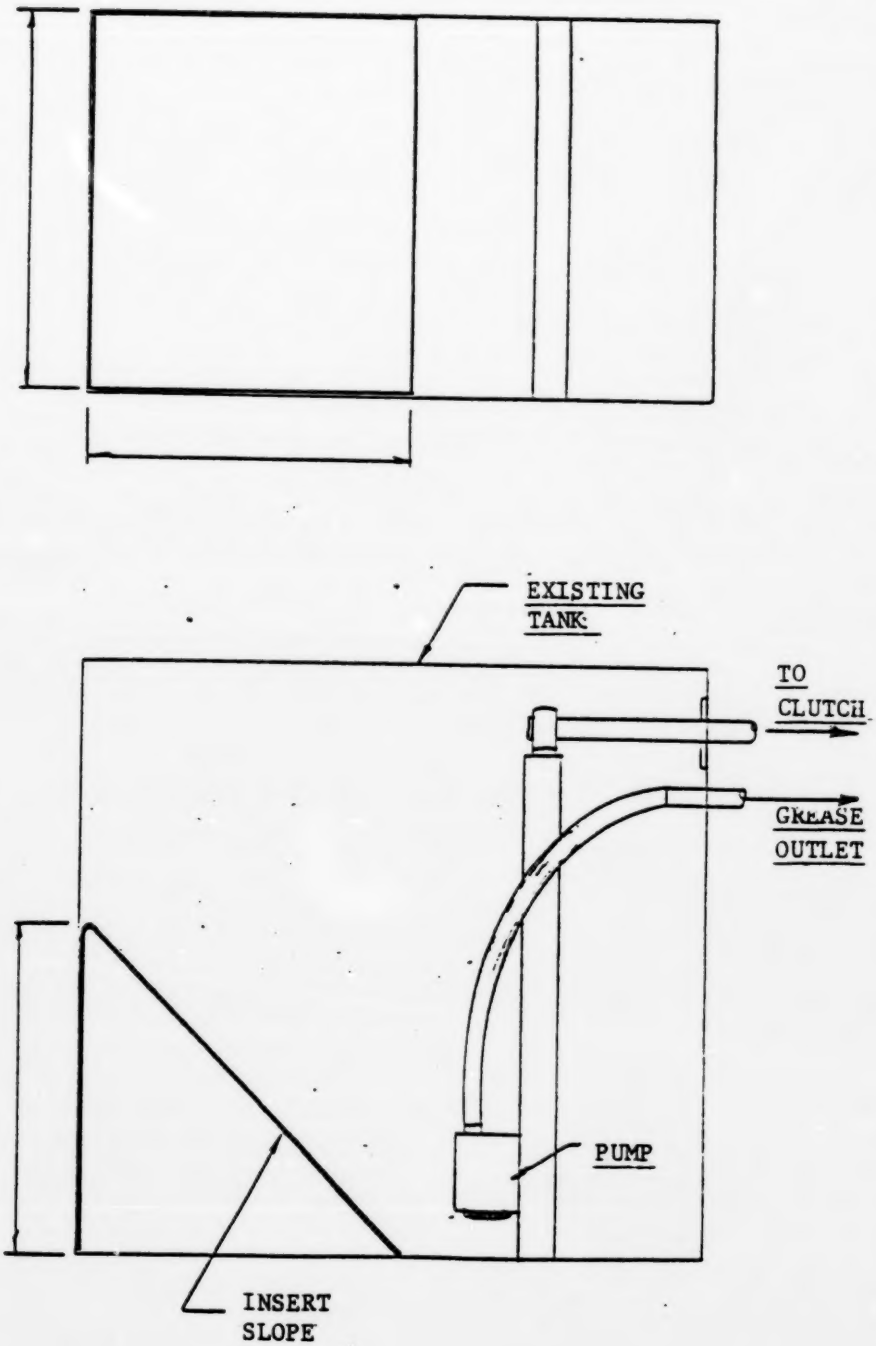
SIDE VIEW



FRONT VIEW

FEATURES OF NEW WIPER BLOCKS

FIGURE No. 2



SLOPED INSERT FOR GREASE TANK

FIGURE No. 3

3.2 RACOR LUBRICATOR

Following the July 1981 report Abex have produced a new Racor Model 4300 track mounted lubricator intended to replace the Model 4000 AW (Figure No. 4). One was installed at Mi. 231 Bala Subdivision in the fall of 1982 and was found to be deficient in the following respect.

- the tank was not water proof resulting in ice, snow and water polluting the grease.
- there was no drain hole in bottom of the clutch assembly resulting in the freezing of the moving parts.
- the clutch assembly was on the low rail with the result that a good portion of the passing wheels did not activate the plunger.
- the pump assembly and cover were one unit and could not be removed by two men but rather required a crane.
- the slope in the tank to eliminate grease puddling was of improper design and did not function as intended.

Because of the above it was decided that in future Abex would supply Racor lubricators incorporating the following features:

1-Model-4000 Reservoir complete with insert tank with slopped bottom

1-Model-4000 Actuator housing assembly

1-Model-4300 Torque rod assembly

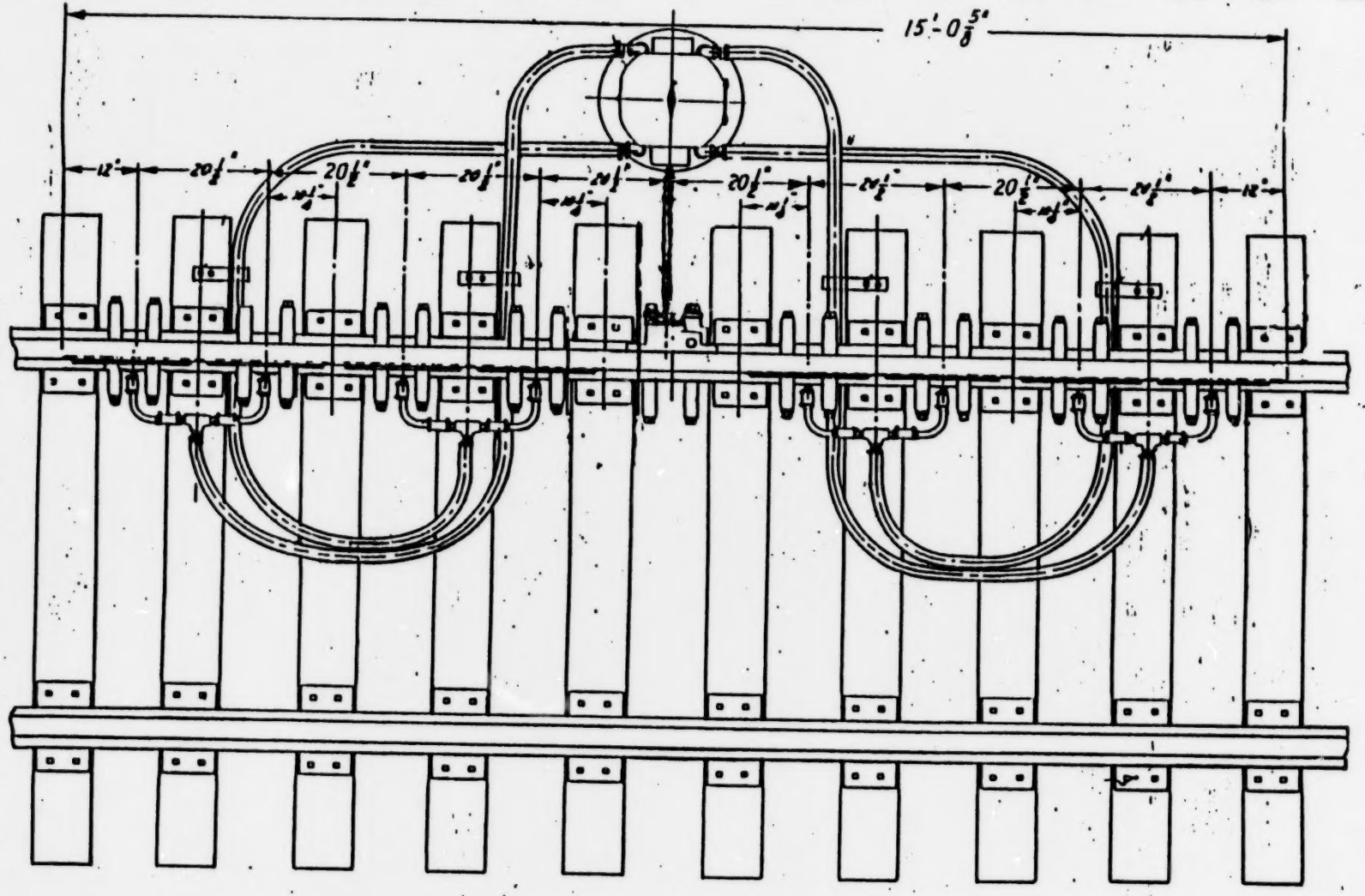
6-Model-4300 Delivery bar assembly - complete

1-Model-4300 Set piping assembly

See Figure No. 5.

Actuator and wiper bars were to be installed on high rail 2-3 rail lengths into the spiral.

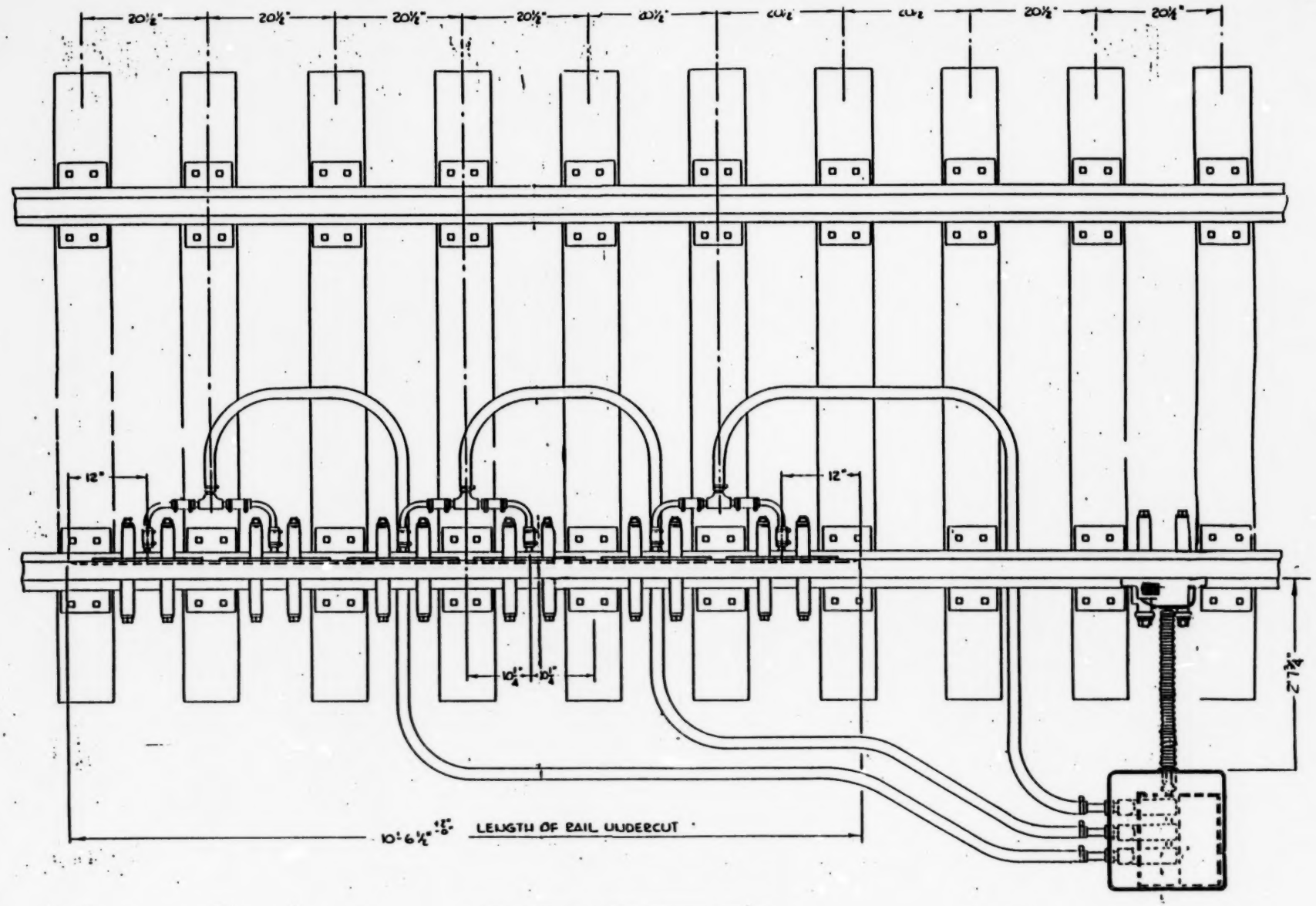
Several of these units were delivered for installation on the Lac St-Jean Subdivision in the fall of 1983. After some field testing the Model 4300 delivery bar and piping assembly proved unsatisfactory. Following this, the Racor MODIFIED 4000 AW lubricator was proposed and is now being tested in the Great Lakes Region and further monitoring will be carried out (see Fig. 6).



RACOR MODEL 4300 LUBRICATOR

ORIGINAL DESIGN

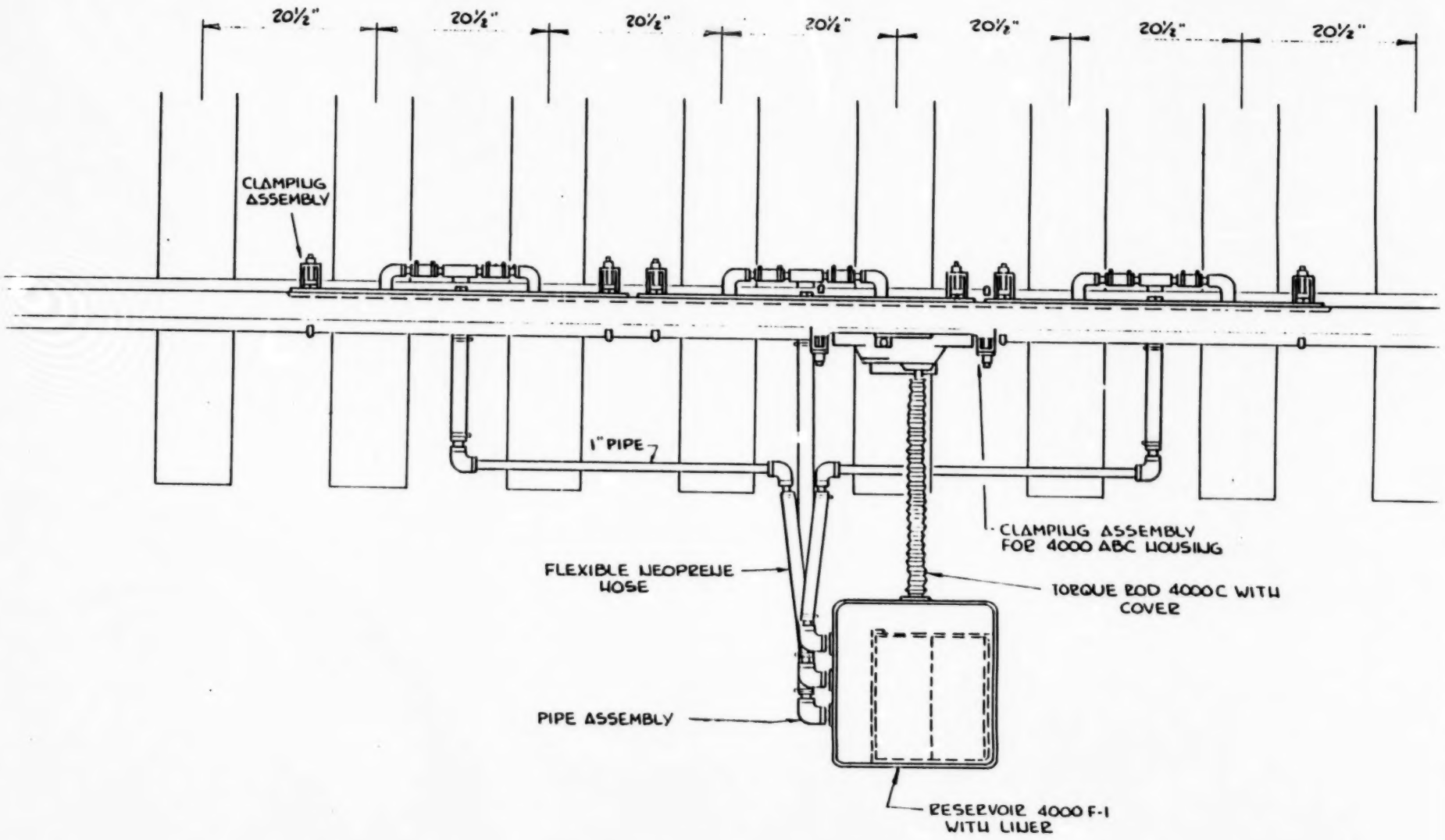
FIGURE No. 4



RACOR MODEL 4300 LUBRICATOR

WITH CN MODIFICATIONS

FIGURE No. 5



RACOR MODIFIED 4000 AW LUBRICATOR

FIGURE No. 6

3.3 TAMPER LUBRICATOR

This unit was tested on the Alexandria Subdivision with the following changes:

The flexible actuator arm was replaced by a length-adjustable type incorporating universal joints as originally developed on the Mountain region.

In spite of the above improvements the unit did not function satisfactorily. Tamper then redesigned their lubricator to incorporate the changes specified by CN (solid drive arm, insert tank, reinforced cover, etc.).

The new version is now being tested in the Great Lakes Region.

3.4 S.R.S. LUBRICATOR

The 1981 Report showed this lubricator to be deficient in many respects. The three units purchased by CN are now out of service. The manufacturer has addressed the problems as outlined by us and indicated that a new version will be available shortly.

3.5 PORTEC

In 1985 a Portec electric lubricator "Protector" was installed on the Newmarket Subdivision for evaluation. This model is powered by 110 V from existing signal lines and is activated by a wheel sensor mounted on the rail. The pump has 6 levels of adjustment varying from 1/4 second to 1-1/2 seconds on per wheel. The length of the pump stroke can also be adjusted in 4 different positions.

Some modifications were made to the original unit and it is now performing satisfactorily. The no-grind wipers were found to wear when installed on spirals and therefore future installations would have the wipers ground in.

Some nice features of electric type lubricators are that there are no parts that come in contact with the wheel and that they are not speed sensitive like mechanical lubricators. They are probably more efficient than mechanical types for installations in yards and where speeds are under 25 MPH (as long as power is accessible).

Trickle charged battery operated lubricators would probably be more feasible where power is restricted. This type will be tested in the future.

3.6 CONCLUSIONS

Work to date has permitted us to formulate a set of guidelines as follows:

3.6.1 Tank and pump assembly

- capacity greater than 200 lb.
- pump to be self priming
- pump output to be adjustable
- assembly to be easily serviceable
- permanent stone screen to be supplied
- reservoir to be watertight and weather proof
- tank cover to be secured
- bottom of grease container to be sloped towards pump
- to have lifting hooks or handles on outside
- to weigh less than 150 lb empty

3.6.2 Actuator assembly

- to be mounted on field side of rail if mechanically wheel activated.
- for single rail installations, activator to be on outside rail of curve.
- for double rail installations, activator to be on tangent track
- to be easily installed and removed for servicing
- mechanical type to have universal type sliding drive arm
- plunger height to be adjustable

3.6.3 Wiper Assembly

- to deliver grease a maximum of 7/8" from top of rail - preferable 5/8
- single rail installations to be in spirals at approx. 1/2" elevation on high rail
- to distribute grease evenly around the circumference of a 36" dia. wheel
- to fit various tie spacings and fastening systems
- to be clamp on type preferably

3.6.4 General Notes

- lubricator to consistently pump approved grease at temperatures between -22°F (-30°C) to 105°F (+40°C)

- suitable for track operating speeds up to 100 MPH or ranges specified

4. TESTING OF LUBRICATOR GREASES

Rail lubricator greases must have the following qualities:

- be pumpable between -20°C and 30°C
- adhere to the rail flange at high temperatures up to 60°C
- remain homogeneous
- be supplied in moisture proof containers

The test specifications as supplied by the grease manufacturers do not respond to the above requirements. As a result, tests were developed at CN Technical Research Centre to define these properties. From the test results combined with field testing, guidelines have been proposed. The testing comprised one method for cold environment and two methods for summer conditions.

Nine (9) greases were tested. Five (5) were called all-year greases, two (2) were winter greases and two (2) were summer greases. Because the behaviour of Texaco 904S and 904W presently used by CN was known these greases were used as reference to evaluate the performance of the other greases. Of the 5 all-year greases, 2 had molybdenum disulphide added. The nine greases are listed below.

1- Texaco MMEP proposed all year grease (molybdenum disulphide added)

2- Texaco 904S Summer grease

3- Texaco 904W Winter grease

4- Shell 1008 Winter grease

5- Shell 1162 Summer grease

6- Shell 1011 proposed all-year grease

7- Esso RCEP proposed all-year grease (molybdenum disulphide added)

8- Esso RMD-TOB - proposed all-year grease

9- Dubois - proposed all-year grease

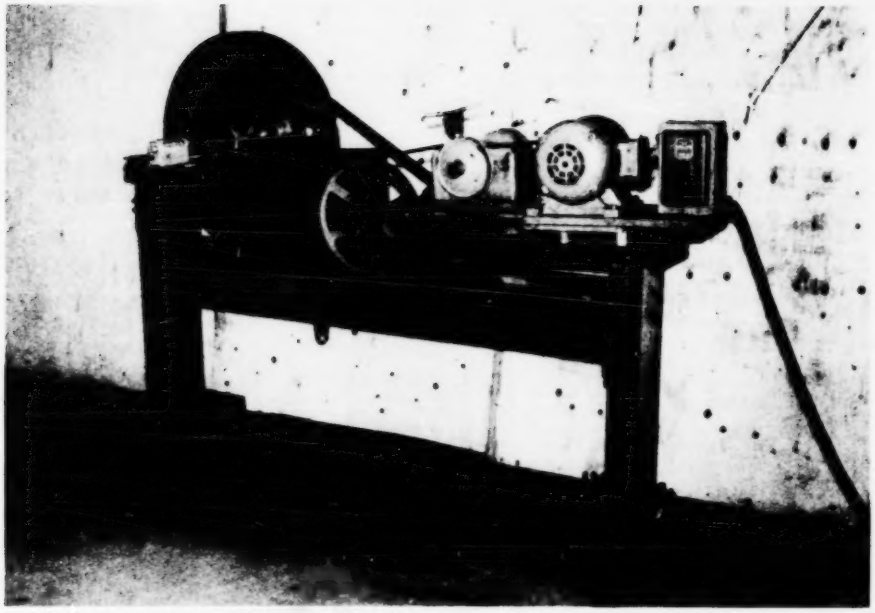
Testing was divided into two main categories, i.e. Laboratory Testing and Field Testing.

4.1 LABORATORY TESTS - WINTER CONDITIONS

The winter laboratory testing was done on a test frame obtained from the National Research Council in Ottawa (see Figure No. 7). The test frame was comprised of a motor-driven flywheel 24 in. diameter and 2 in. thick with two cam lobes and had been developed to do cold chamber tests on rail curve lubricants. However, because the purpose of the tests undertaken previously was to evaluate the performance of various lubricators rather than study low temperature behaviour of rail lubricants, the following changes were carried out:

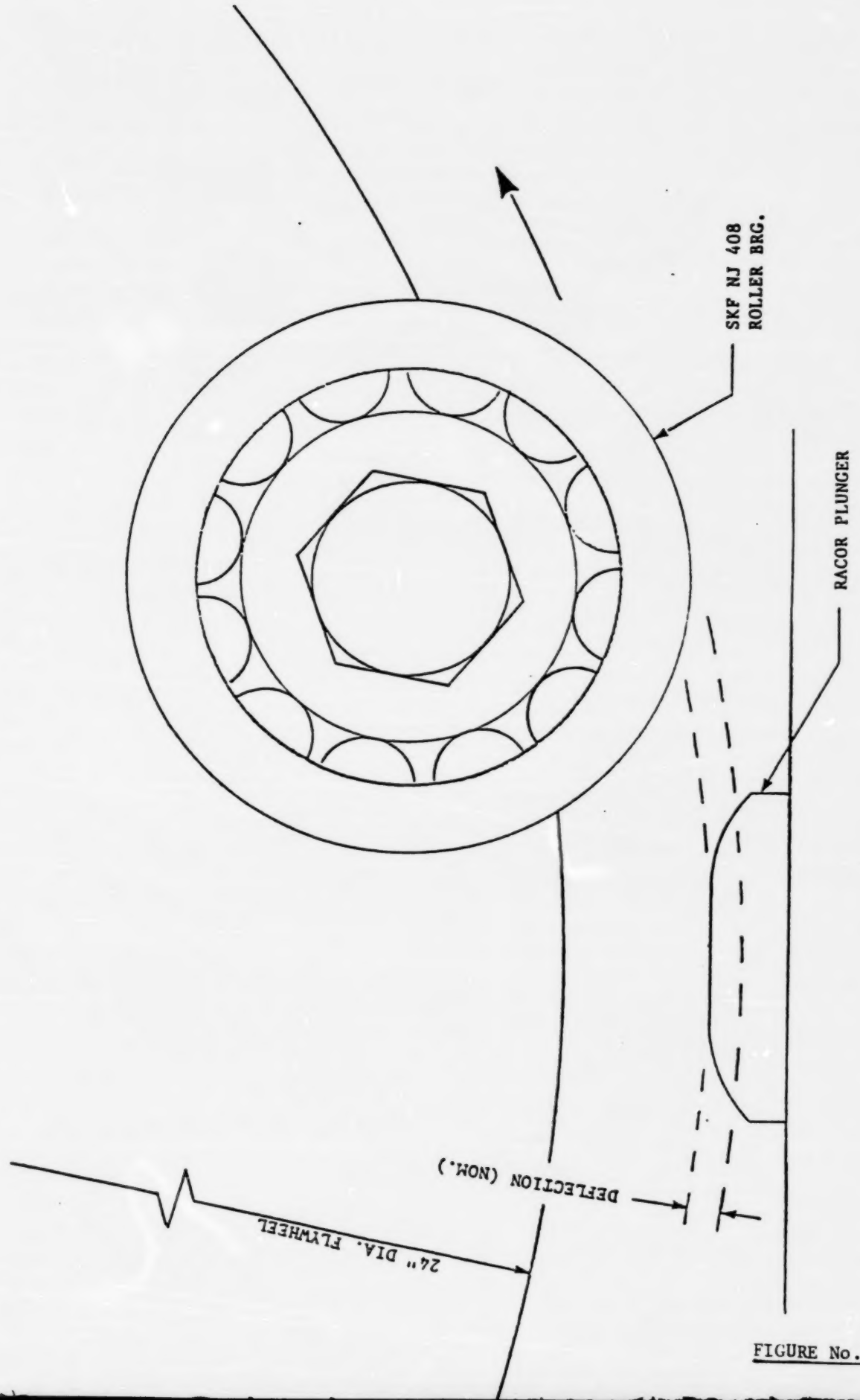
- A variable speed transmission was installed which permitted simulating train speeds between 20 and 60 mph.

- The cam lobes supplied with the unit were replaced with roller bearings (see Figure No. 8). This eliminated a problem initially encountered of rapid fatigue damage to the lobes from heavy impacts.



Test frame obtained from National Research Council, Ottawa to do laboratory testing.

FIGURE No. 7



TEST BENCH OPERATION

FIGURE No. 8

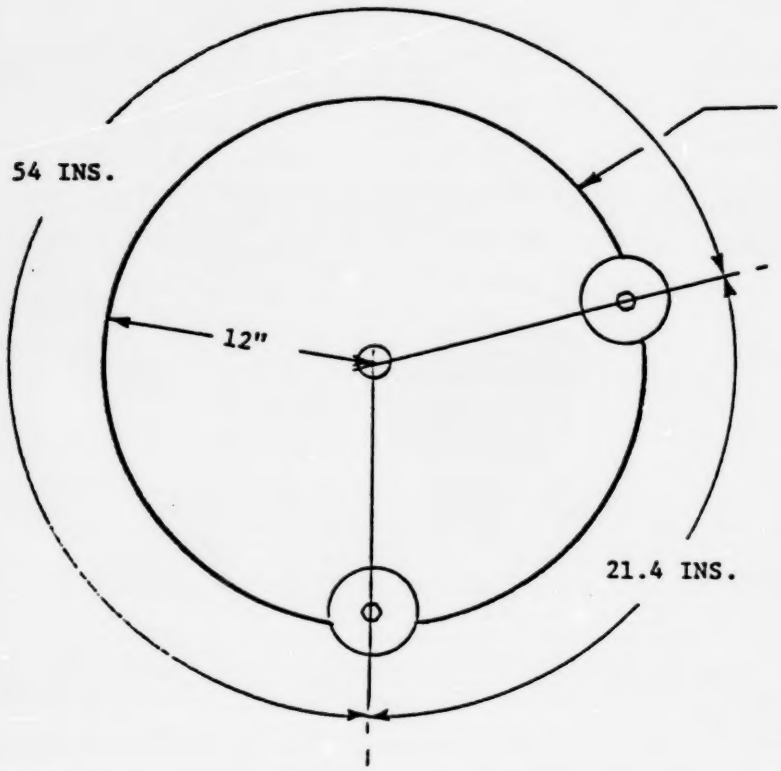
The roller bearing lobes were spaced on the flywheel as shown in Figure No. 9A. This imposed a rhythm of impacts on the lubricator under test, resembling a train with wheel spacings as shown in Figure No. 9B. The ratio of freight car truck wheel spacing (70 in.) to equivalent spacing on the bearings on the flywheel (21.4 in.) is 3.26. The circumference of the flywheel is 6.28 ft. and one rpm = 6.28 ft./min. or 0.0714 mph. By introducing the ratio of 3.26, one rpm of the flywheel gives a simulated train speed of 0.2328 mph.

Test duration for each condition was 1000 impacts (wheels), therefore simulating 250 cars or in excess of 2 trains.

The laboratory testing comprised cold room temperature testing, i.e. testing at temperatures below 0°C to measure grease deliveries.

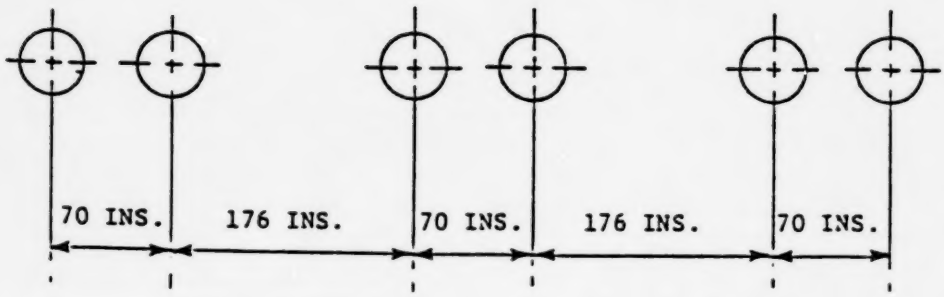
The static plunger deflection was held constant at 0.150 in. The test frame was placed in a refrigeration chamber and temperature was varied between 0°C (32°F) and -34°C (-30°F). Speed was held at 40 mph. Testing was done in the restricted mode only (i.e. with wiper blades attached).

The results for the 9 greases in weight of grease pumped per 1000 wheels at various temperatures are shown in Table No. 1 and in Figures Nos. 10-11-12.



FLYWHEEL ASS'Y ON TEST RIG

FIGURE NO. 9A



EQUIVALENT DISTANCES BETWEEN IMPACTS
ON TEST RIG

FIGURE NO. 9B

TABLE No. 1 - WEIGHT OF GREASE PUMPED AT VARIOUS TEMPERATURES AND 40 MPH POUNDS/1000 WHEELS

GREASE / TEMP.	Texaco MMEP A	Texaco 904S S	Texaco 904W W	Esso RCEP A	Esso RMD-TOB A	Shell 1162 S	Shell 1008 W	Shell 1011 A	Dubois A
0°C 32°F	2.0	1.8	2.2	1.6	1.7	.7	2.4	2.2	1.95
-9°C 15°F	1.9	1.6	2.2	1.55	1.6	.9	2.1	1.85	1.8
-18°C 0°F	1.9	1.7	2.0	1.55	1.5	.8	1.8	1.55	1.6
-23°C -10°F	1.8	1.4	1.8	1.55	1.5	.4	1.8	1.45	--
-28°C -20°F	1.80	--	2.0	1.45	1.4	.2	--	1.1	1.20
-34°C -30°F	1.2	--	1.2	1.4	1.4	0	1.7	1.0	.75

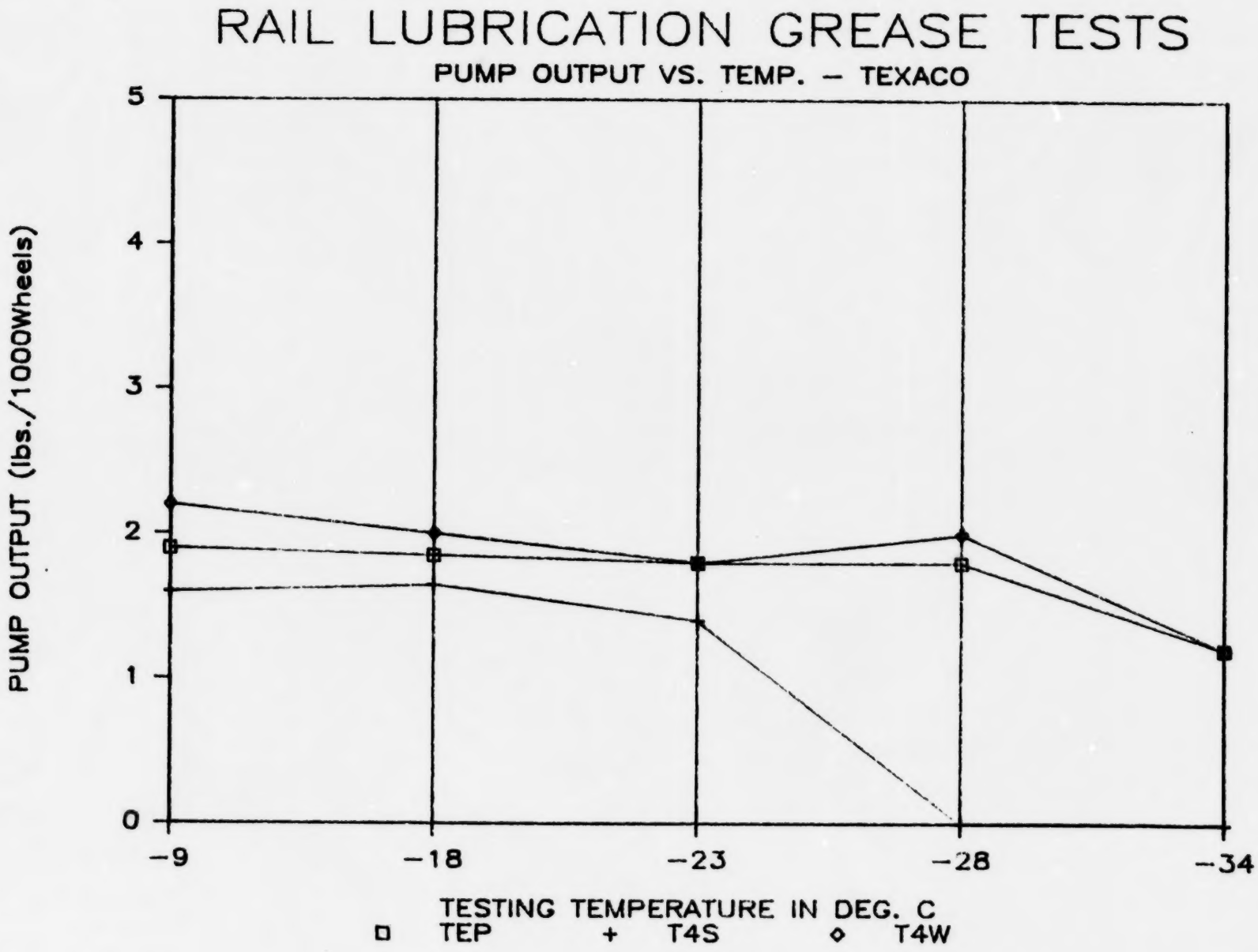

RAIL LUBRICATION GREASE TESTS
PUMP OUTPUT VS. TEMP. – TEXACO
PUMP OUTPUT (lbs./1000Wheels)
5
4
3
2
1
0
-9
-18
-23
-28
-34
TESTING TEMPERATURE IN DEG. C
TEP
T4S
T4W

Figure No. 10

RAIL LUBRICATION GREASE TESTS

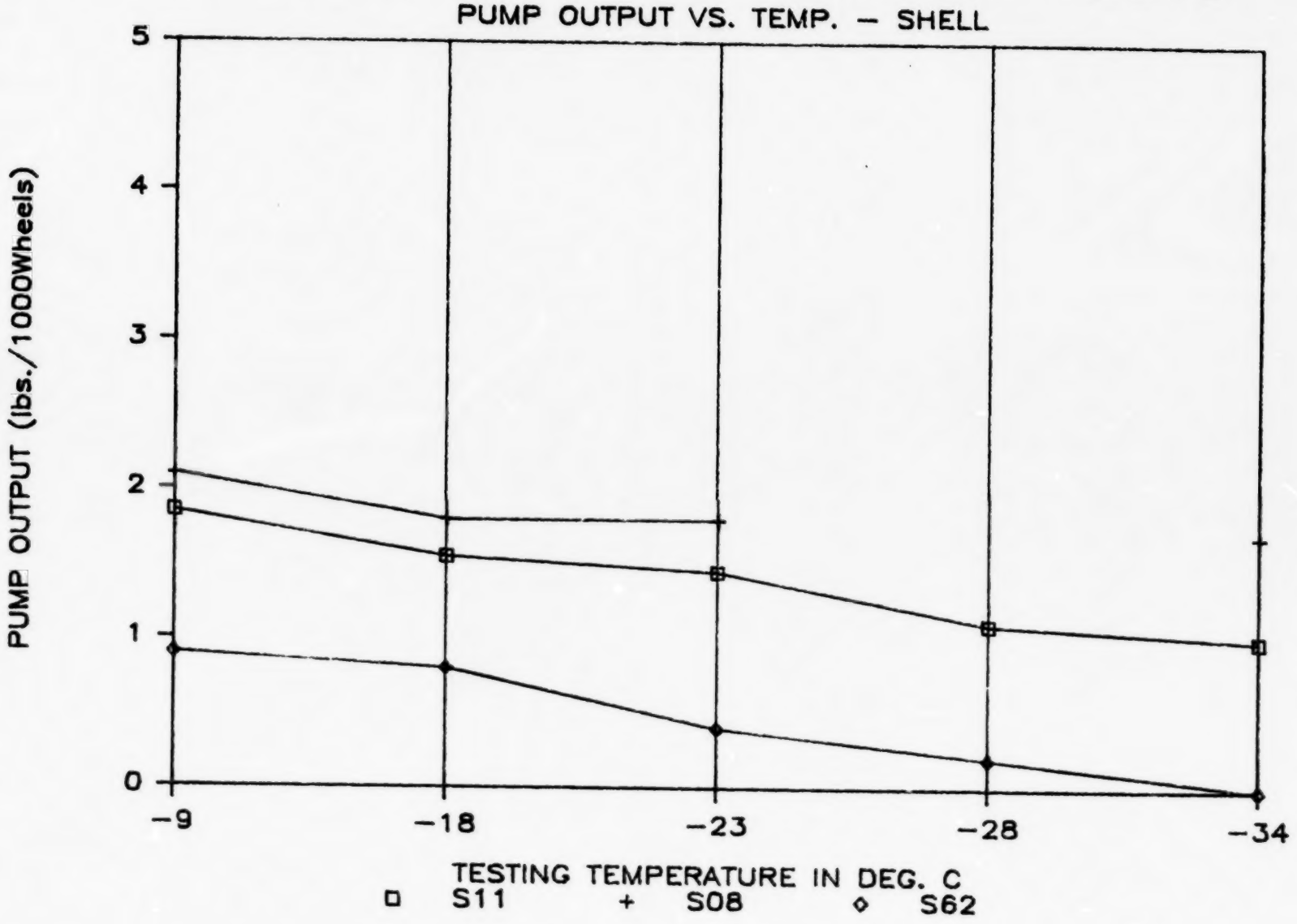


Figure No. 11

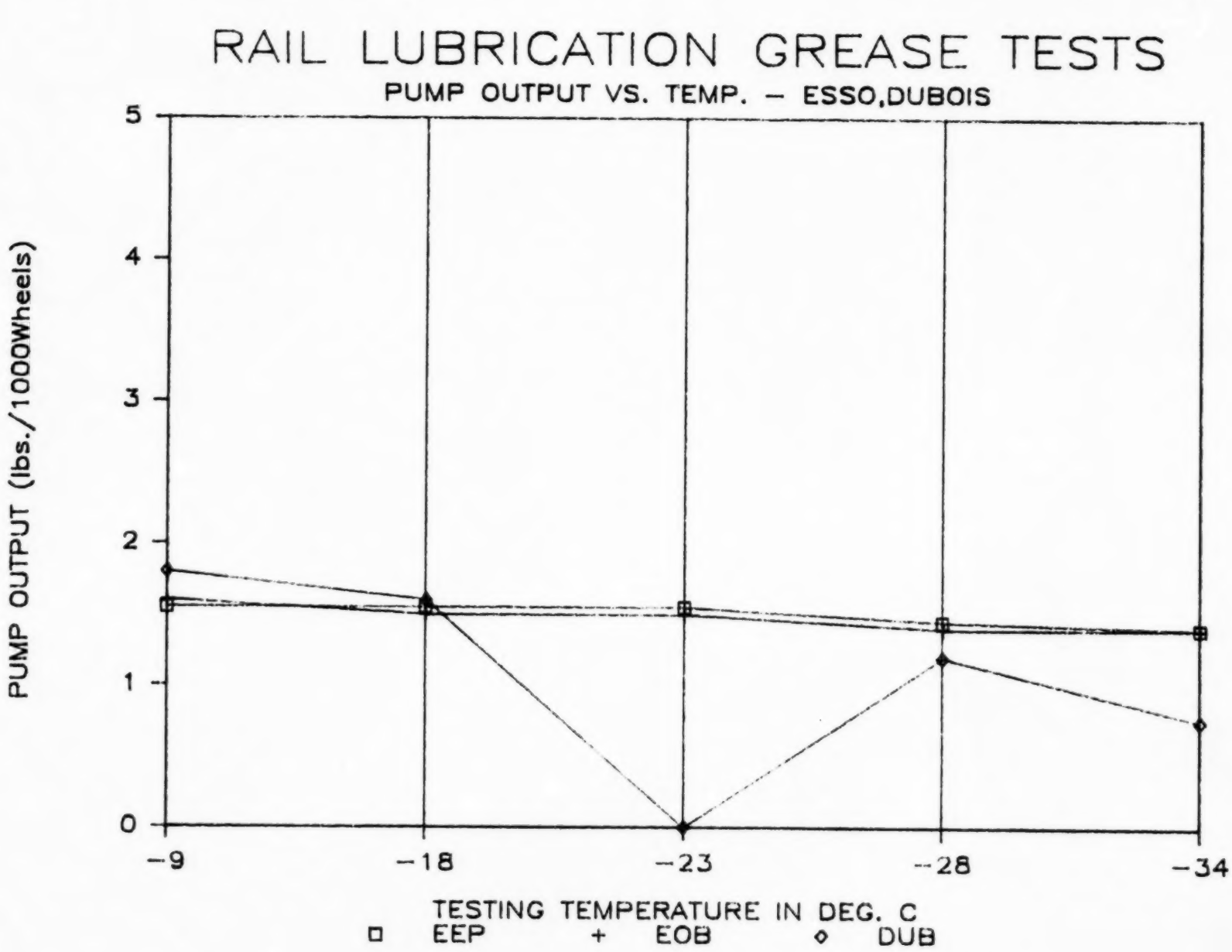

RAIL LUBRICATION GREASE TESTS
PUMP OUTPUT VS. TEMP. – ESSO,DUBOIS
PUMP OUTPUT (lbs./1000Wheels)
5
4
3
2
1
0
-9
-18
-23
-28
-34
TESTING TEMPERATURE IN DEG. C
EEP
EOB
DUB

Figure No. 12

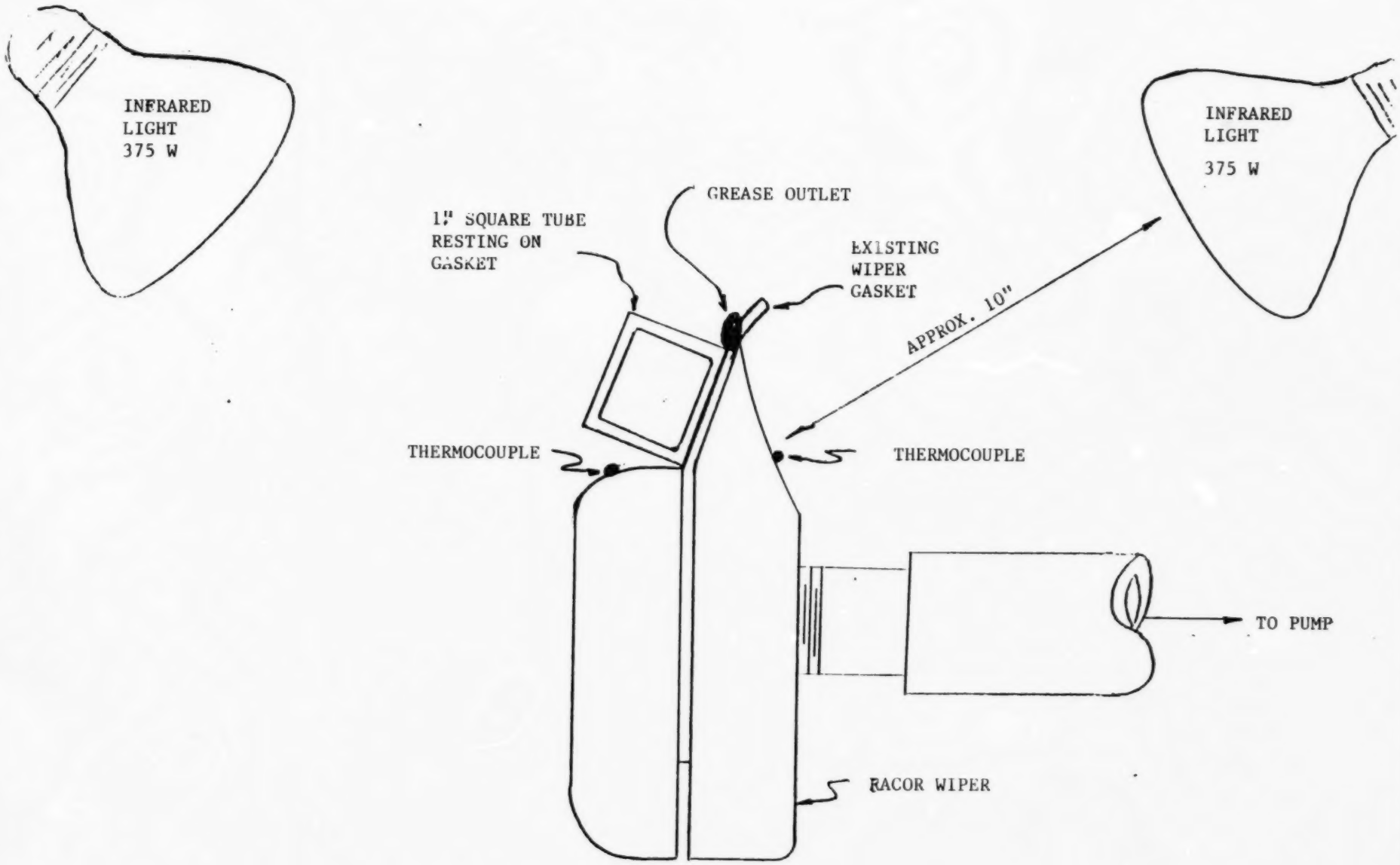
4.2 LABORATORY TESTS - SUMMER CONDITIONS

The same materials were used for this test as for the Cold room tests described above.

An initial test to evaluate hot weather performance of the greases was devised where the wiper blades were attached to a 1" square metal tube to simulate a rail head. The wiper ports were filled with grease and wiped flush with the wiper outlet (Figure No. 13).

A 375 watt infrared light was placed on both sides of the wiper approximately 10" away. The light was left on until the temperature of the grease inside the wiper bar was 140°F (60°C). Thermocouples glued to the wiper and inside the wiper outlet were used to measure temperature. At this point, grease was pumped out until a bead of approximately 1/2" in height protruded from the wiper and was left for 5 minutes with the heat lamps turned off. The lights were then turned on and left on for an additional 5 minutes.

The results were evaluated by visual observation of the behaviour of the various samples. Those which deformed the least were the most competent.



HOT WEATHER TEST APPARATUS

FIGURE No. 13

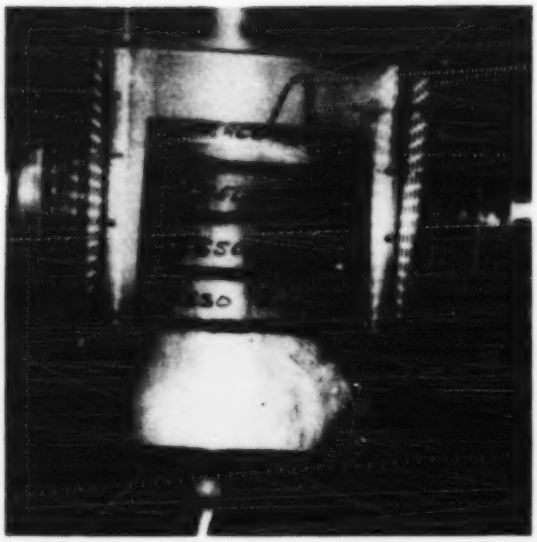
In order to evaluate the ability of greases to adhere to heated surfaces, a second test was devised.

In this test, a sanded and washed aluminum plate 12" x 16" was used. Beads of each sample under test were spread horizontally on the plate. Each bead was 1/2" thick by 6" long. Up to six samples could be tested simultaneously.

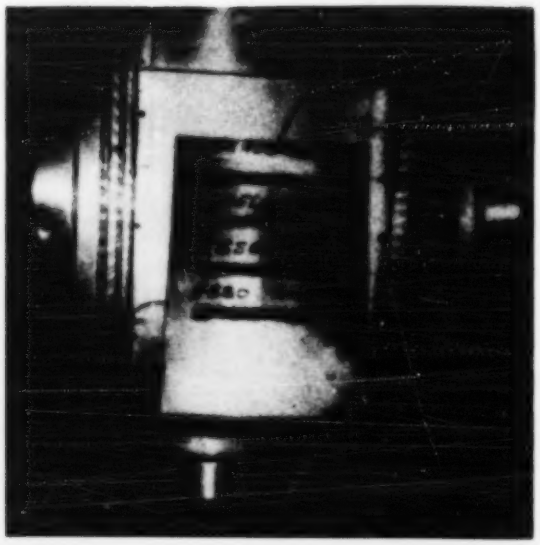
The aluminum plate was placed in a tray and transferred to a temperature controlled Laboratory Oven. The plate was placed at an angle of 75° to the horizontal. The temperature in the oven was raised slowly to 180°F and then removed for observation.

The results were evaluated by visual observation of the behaviour of the various samples. Those which deformed the least were the most competent. (See example photos in Figures Nos. 14 and 15.

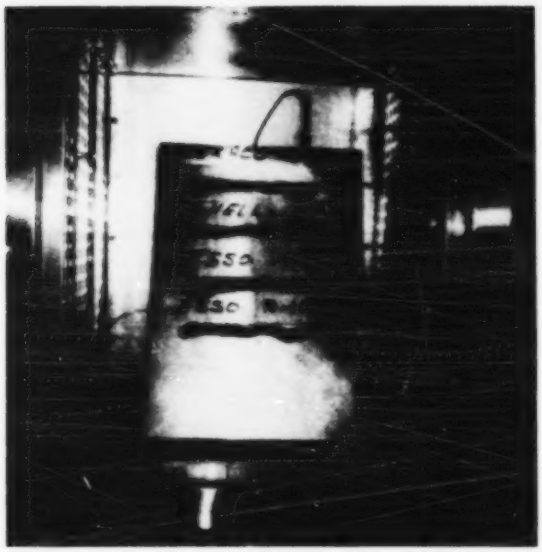
Table No. 2 shows observations made from these tests and the cold room pumping test.



START



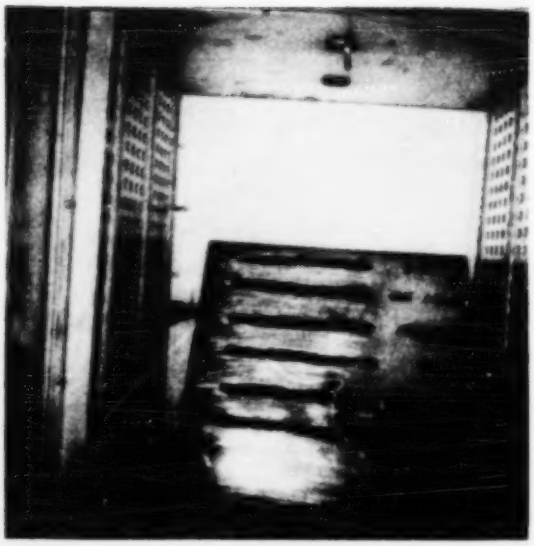
170°F (77°C)



180°F (82° C)

PHOTOS OF HOT WEATHER TFST

FIGURE No. 14



100°F 3rd TEST
38°C

150°F 3rd TEST
65°C

175°F 3rd TEST
79°C

PHOTOS OF HOT WEATHER TESTS

FIGURE No. 15

TABLE NO. 2

OBSERVATIONS OF GREASES

SUMMER & WINTER CONDITIONS

Grease No. and Co.	Summer Conditions	Winter Conditions
Texaco 904S	Good	Good to -15°F
Texaco 904W	Bad (too light)	Good
Texaco MMEP	Good	Good
Shell 1008	Bad (separated)	Good
Shell 1162	Good	Bad - low pumping output
Shell 1011	Good - slightly oily	Good - slightly low pump output
Esso RCEP	Good	Good
Esso RMD-TOB	Good	Good
Dubois	Bad - very oily	Bad - low pump output

4.3 CONCLUSIONS FROM LABORATORY GREASE TESTS

From these tests 4 greases were held as candidates for all-year grease. They were
TEXACO MMEP, SHELL 1011, ESSO RCEP and ESSO RMD-TOB.

Three of these greases, TEXACO MMEP, SHELL 1011, and ESSO RMD-TOB were used in lubricators on the Alexandria Subdivision for a period of 1 year. See paragraphs on Field Testing.

4.4 FIELD TESTING

The final part of evaluating a grease for all-year conditions was the field test. Three greases, TEXACO MMEP, SHELL 1011, and ESSO RMD-TOB were placed in lubricators on main line and monitored for a period of 1 year. The lubricators were visited regularly and kept in operating condition. The fourth grease, ESSO RCEP, was not field tested since we were trying to find an all-year grease without moly disulphide. Moly disulphide greases are almost twice as expensive as regular greases and we are not in a position to justify this cost as far as rail life is concerned. The TEXACO MMEP was field tested to compare a moly disulphide grease with the 2 other proposed all-year greases which did not have moly disulphide.

4.4.1 Results from Field Testing

The three greases performed well through the winter and summer conditions. The TEXACO MMEP was the most consistent. The SHELL 1011 turned slightly oily in summer but not enough to cause it to run. The ESSO RMD-TOB initial batch became very oily in spring. The cause as explained by ESSO was attributed to a bad mixing procedure not to recipe. A second batch was made up using the same recipe and the field test was continued. The second batch performed well in summer conditions.

4.4.2 Conclusions from Field Testing

Since there is insufficient information to economically justify the rail wear retarding properties of moly disulphite grease at the present time, only 2 greases tested are retained as candidates for an all-year type grease: SHELL 1011 and ESSO RMD-TOB. A specification will be written in order that CN will be able to control the quality and mixture of the greases supplied.

4.4.3 Action Taken

In September 1986, CN discontinued ordering Texaco 904S and 904W summer and winter grades of grease, and switched to the following all-year greases:

		Region
ESSO	Galena RC1200 (old RMDTOB)	Atlantic
TEXACO	Marathon Moly EP (1)	Great Lakes & St. Lawrence
SHELL	Candar 22* (old 1011)	Prairie and Mountain

The performances of these greases will be observed over the next year.

(1) A limited quantity of Texaco moly grease, supplied at an attractive price, will be tested while Texaco work on the development of an all-year graphite grease.

5. LUBRICATOR INSTALLATION PROCEDURE

5.1 INTRODUCTION

This lubricator installation guide will ensure that lubricators provide efficient rail lubrication. It is also intended to avoid installations in undesirable locations (grades, towns, etc.). The values arrived at in this system should be adhered to as closely as possible. However field conditions might dictate making adjustments. In such cases intimate knowledge of the trackage and lubricator performance will be helpful in determining the final locations. Guidance from track personnel will be essential at this point.

5.2 INFORMATION REQUIRED

To determine the installation location of these lubricators the following is required:

1. Condensed track profile which has total angle of curvatures (T.A.C.) of the subdivision to be covered.

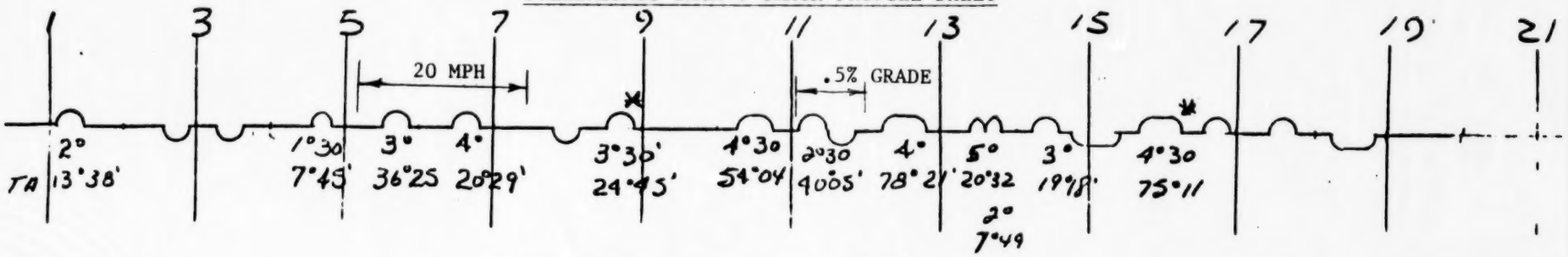
2. Timetable for speed zones, stopping locations, bridges and tunnels.

3. Removable markers to pinpoint locations on condensed profile.

4. Preliminary data and track profile sheet and rail lubricator location sheet (see Tables Nos. 3 and 4).

TABLE NO. 3

PRELIMINARY DATA & TRACK PROFILE SHEET



TWO-WAY TRAFFIC, SINGLE RAIL INSTALLATION

Mileage	Curves 2° & up	Total Angle	Total Angle X Factor	Sum Total of Angles	Comments
SMITHERS					
1.3	2°	13° 38'	20.4		DRY
5.5	3°	36° 25'	36.4		RAIL
6.4	4°	20° 29'	20.5		
8.6	3° 30'	24° 45'	24.7	102.0	
8.8	RACOR LUB RIGHT HAND RAIL				
10.3	4° 30'	54° 04'	54.0		
11.2	2° 30'	40° 05'	60.15		
12.3	4° 0'	78° 21'	78.3		WET
13.4	5°	20° 32'	20.5		RAIL
13.6	2°	7° 49'	11.7		
14.3	3°	19° 18'	19.3		
15.8	4° 30'	75° 11'	75.2	319.15	
16.2	RACOR LUB RIGHT HAND RAIL				
16.6	5°	77° 17'	77.3		
17.4	4°	22° 46'	22.7		

SUBDIVISION: BULKLEY

CURVES: LEFT

DATE: JUNE 1985

TABLE NO. 4 Rail Lubricator Location Sheet

(SAMPLE)

Subdivision: Bulkley Date: September 1982

Mi. of Inst'n.	Curve Degree R or L	Lub. on R or L Rail	Lub. Type & Mod.	Wt. of Rail	Mi. per Formula	Remarks
5	3° R	LH	RACOR 4000A	115#	5.0	O.K.
6.4	4° L	RH	RACOR 4000A	115#	8.8	Moved acc't. of siding
12.8	3° R	LH	RACOR 4000A	115#	13.4	Moved to up side of curve
16.6	5° L	RH	RACOR 4000	115#	16.2	Existing @ 16.6 - leave
18.4	4° R	LH	RACOR 4000A	115#	18.4	O.K.

*Example only - figures may vary from real study.

On the track profile, mark off all regular stopping points for freight trains such as yards and regularly used sidings. Using a timetable, mark off all speed zones 20 MPH and under, tunnels and bridges. Also mark off all grades over 0.5% since lubrication is prohibited in these instances due to possible wheel slippage and sanding. At this point, determine whether this line has 2-way traffic or 1-way traffic.

5.3 TWO-WAY TRAFFIC, SINGLE RAIL INSTALLATION

1. This system is based on the premise that a lubricator is capable of covering a minimum of 150 degrees of total contained angle in each direction from the lubricator location under two-way traffic. The initial lubricator locations do not take into account restrictions caused by grade, etc. as this is addressed later.

   In a two-way traffic system, the lubricator greases the curves in both directions. Therefore the distance between lubricators for two-way traffic should be greater than for one-way traffic.

   Assuming that the beginning of the S/D is at a terminal, the total angle of curvature (T.A.C.) for every left hand curve 2° and over is determined. Always proceed east to west.

   The total angle of every left hand curve between 2 degrees and 2 degrees 29' is multiplied by a factor of 1.5.

   Example: Left hand curve 2 degrees 10' with a total angle of 20 degrees 30', (which is 20.5 degrees) by 1.5 = 30.75.

   Use 30.75 instead of 20.5 when adding up the total angle for that curve.

   The total angle of every left hand curve 3 degrees and over is summed. There is no multiplication factor for curves 3 degrees and over.

   The total angles of all left hand curves are added until a figure closest to 100 degrees is reached. A marker is placed at the west end of that curve (see example). This represents the location of the first lubricator.

2. Starting at this marker, continue adding the total angles for the left hand curves of 2 degrees and up, using the above formula, until a value closest to 300 degrees is reached and place a marker at this location. Repeat this procedure until the major stopping point has been reached and place a marker each time a value for total angle of 300 degrees is achieved. If after 10 miles the sum of the total angles has not reached 300 degrees the rail is considered dry. Therefore, at the next major curve, around the 10 mile mark, the total angles are added up until 100 degrees is reached. A marker is placed at this point and then a value of 300 degrees is reached. A marker is placed at this point and then a value of 300 degrees for total angle is used after that point. Where a small group of curves are isolated a lubricator should be located in the centre of the group of curves and the counting restarted at the next curved area.

   As the end of a subdivision is approached, the sum of the total angles may be less than the specified 300 degrees, in which case judgement will dictate whether another lubricator is required.

   At this point of the analysis, direction of heavy traffic is determined and markers are moved to the approach end of the curves to be lubricated.

   The same procedure is repeated for all the right hand curves of 2 degrees and up, starting at the beginning of the Subdivision and proceding from each to west. Place markers to show preliminary lubricator locations.

   After both left and right hand curves have been completed, a visual inspection of the track profile is carried out. If some markers fall into the following areas they are relocated to the closest curve of 3 degrees and up, outside the prohibited area:

   A. Speed zone under 20 mph
   B. Regularly used sidings
   C. Tunnels
   D. Bridges
   E. 2 degrees to 2 degrees 59' curves
   F. .5% grade and over

   Even though 2 degree curves are tabulated, lubricators are only installed on curves of 3 degrees and up. If a marker is on a grade of 0.5% or over, the marker is moved to the upper end of the grade and at least 1 mile beyond the top of the grade. If this location conflicts with another marker, one will be removed and the other relocated at approximately mid-point of these 2 locations.

If a marker on the left hand curve falls within 1 mile of a marker on the right hand curve, one will be moved to a curve 3 degrees and up at least 1 mile away. This is done to avoid heavy grease on both wheels, thus causing slippage on grades.

Optimum condition is when lubricators are staggered and near the midpoint of each other.

5.4 ONE-WAY TRAFFIC, SINGLE RAIL INSTALLATION

For one-way traffic the guidelines are the same with the following exceptions:

1. The first lubricator is installed at the beginning of the first curve.

2. The figure used for locating the next lubricator is 225 degrees instead of 300 degrees total angle. The value of 225 degrees is about the maximum range of a single lubricator without benefit of the overlapping of an adjoining unit as in two-way traffic territory.

5.5 TWO-WAY TRAFFIC, DUAL RAIL INSTALLATION

Where dual rail installations are preferred the same procedure applies, with the exception that both right and left curves are added up to make the 100° or 300° total angle figure. In dual rail installations the lubricator is placed in the tangent usually between two opposite curves, therefore, the need to determine the direction of heavy traffic is eliminated but should always be installed close to curves 3° and up.

5.6 ONE-WAY TRAFFIC, DUAL RAIL INSTALLATION

For dual rail installations on one-way traffic, the same guidelines apply using 225° instead of 300° total angle and adding up both right and left curves, and installing lubricator on tangent between 2 curves 3° and up preferably.

5.7 FIELD SURVEY

After the locations are finalized, the results are entered on the rail lubricator location sheet (Table 4) and a field survey is made. During this field trip, the wear on the curves is monitored to determine the need for lubricators at each location. Also, the sites are inspected to ensure that a lubricator can be installed at that location. If, due to physical constraints not shown on the profile, a location is not suitable, the lubricator is moved to the next curve of 3 degrees or over.

The lubricator location is checked off on the rail lubricator location sheet as being satisfactory, or a note is made explaining why the location was changed.

A final version of this sheet is prepared and sent to the personnel responsible.

Notes:

1. Single rail lubricators are to be installed in the spiral at approximately 1/2" rail superelevation, which is usually 2 to 3 rail lengths into the curve (approximately 100 ft.), or at first sign of flange contact. Double rail lubricator installation is not recommended, but if a subdivision requires it, the dual rail procedure should be used.

2. If existing lubricators on the subdivision being surveyed are of the same capacity and fall within 1 mile of the plotted location, they should not be removed; just delete the location arrived at in the formula.

6. GENERAL CONCLUSIONS

Before this study commenced, rail lubricator performance was less than satisfactory, and a good proportion of lubricators were inoperative on account of mechanical failures. Lubricator maintenance was a headache because lubricators were not designed for ease of maintenance. CN had been purchasing separate grades of summer and winter grease, and timely changeover in spring and fall created difficulties. In the fall, if the summer grade grease was not cleaned out of the lubricator in time, it would solidify to the point of not being pumpable, and if the winter grade grease remained in the lubricator for too long in the spring, it would flow all over the track.

It cannot be stated that all problems have been solved, but certainly a major step has been made in that direction. Lubricator and grease suppliers are now fully aware of the demands being made upon them, and improvements will continue to be made.

7. RECOMMENDATIONS

Work should be continued on this project to more fully evaluate the field performance of modified lubricators and relatively new all-year greases. Because of the potentially significant savings to be obtained through controlled lubrication, there should be no rest until completely satisfactory results are achieved.